TransformTO Green Infrastructure

Green Infrastructure

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Introduction

"The most livable city in the world" - this is the goal that the TransformTO project sets out for Toronto. The City of Toronto has set a goal of reducing greenhouse gas emissions by 80% by the year 2050. Through engagement with Toronto's residents and businesses, the project aims to produce a framework for decision-making that will help to identify key starting points and areas for improvement in Toronto's sustainability efforts. A short-term strategy on how Toronto will meet its 30% reduction target by 2020, and a long-term plan on how to meet the larger 2050 goal will both be produced from the TransformTO consultative process. An important element in both the short and long term strategies is increased green infrastructure within the city.[1] To assist in this plan, the City of Toronto partnered with the Master of Global Affairs capstone program at the Munk School of Global Affairs within the University of Toronto. City staff requested that students investigate the current state of Toronto's green infrastructure, research policies and initiatives in other cities, and identify opportunities for Toronto to improve its own programs and encourage additional green infrastructure projects.

Background

The City of Toronto subscribes to the definition of green infrastructure that was identified in Ontario's Provincial Policy Statement of 2014. The document defines green infrastructure as "*natural and human-made elements that provide ecological and hydrological functions and processes. Green infrastructure can include components such as natural heritage features and systems, parklands, stormwater management systems, street trees, urban forests, natural channels, permeable surfaces, and green roofs*".[2] In early meetings, city staff identified some of the unique concerns to Toronto, highlighting flood management and the urban heat island effect, where cities are significantly warmer than their rural surroundings because of more energy from people and cars.[3] In choosing a few elements of green infrastructure on which to focus, it was important that these concerns be considered. There was a particular interest in expanding existing programs within the city, so emphasis was placed on examining aspects of green infrastructure that the city already works on. Three categories of green infrastructure were identified as especially relevant based on these concerns and existing policies within Toronto: green roofs, trees and canopy coverage, and public green spaces.

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[1] Toronto. (2016). TransformTO. *City of Toronto.*

[2] Ontario. (2014). Provincial Policy Statement. *Ministry of Municipal Affairs and Housing.*

[3] National Geographic. (n.d). Urban Heat Island. *National Geographic Education*.

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Green Roofs

Green roofs are rooftop systems designed to allow for plant growth atop human-made structures. At a minimum, a green roof includes a root repellent system, a drainage system, a filtering layer, soil or another growing medium, plants, and a waterproof membrane.[4] Green roofs offer numerous environmental benefits, including reducing stormwater runoff, energy consumption, and the urban heat island effect, as well as improving air quality. The City of Toronto estimates that green roofs account for a reduction of 12 cubic metres of stormwater runoff per year, saving the city between $42.5 and $119 million annually from infrastructure, erosion control, and pollution control savings, as well as revenue from addition open beach days. The city also saves $21 million annually from reduced energy required for cooling, and an additional $12 million could be saved with a reduction of the urban heat island effect of between 0.5 and 2 degrees. The saved energy from cooling results in a reduction of carbon dioxide emissions, and the roofs themselves offer absorption capabilities to reduce levels of CO, NO_2, O_3, PM_{10}, SO_2. Green roofs also present opportunities for local urban food production, wildlife habitation, and general improvements of biodiversity in Toronto.[5]

Tree Canopy

The tree canopy of a city is measured by the proportion of land area that is covered by tree crowns, from an aerial view. Tree canopy as a percentage of total city coverage is used as a metric because it is widely used, making comparisons between cities easy, and also because it is easy to evaluate the success of urban forest management plans by analyzing the change in canopy coverage over time.[6] Trees within urban settings serve important environmental purposes, but have also shown significant impact on public perception of the quality of a community. Trees differ from other forms of green infrastructure, as their value increases over time, rather than the depreciation effect seen on other infrastructure projects. Toronto's urban forest benefits the public by providing ecological services, recreational opportunities, health benefits, and economic advantages in the real estate and commercial markets.[7] Financially, Toronto's urban forest provides ecological services valued at $28.2 million, it reduces heating and cooling bills by $10.2 million, and it improves air quality to a value of $16.9 million annually.[8]

Public Green Spaces

Urban public green spaces include parks, reserves, sports fields, riparian zones of streams and riverbanks, greenways, trails, community gardens, and nature conservation areas. These sorts of public green spaces are known to promote physical activity among populations, directly reducing risks for obesity and many

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[4] Toronto. (2016). Green Roofs. *City of Toronto*

[5] Ibid

[6] Urban Forest Management Plan Tookit. (2016). Assess Canopy Cover. *California Urban Forests Council*.

[7] Toronto. (2016). Every Tree Counts: A Portrait of Toronto's Urban Forest. *City of Toronto*.

[8] Ibid

other diseases, and to improve psychological wellbeing through reducing stress and offering solitude, allowing these areas to contribute significantly to public health within cities. Further, green spaces can filter air, remove pollution, mitigate noise, reduce temperatures in the urban heat island, absorb storm water, replenish groundwater, and act as an organic source of food. There are also studies that have linked childhood development to park proximity, showing a reduction in behavioural problems and in symptoms of attention deficit disorder among children who live closer to parks.[9] Toronto has estimated that green spaces could reduce the urban heat island effect in green spaces by up to 7ºC, as compared to adjacent non-green areas.[10] Aside from this figure, the city has largely not quantified the benefits of public green spaces, making it difficult to measure and compare with other cities.

Methodology

In order to provide appropriate recommendations on improving green infrastructure programs to the City of Toronto, it was important to first investigate what initiatives the city has in place. This process involved reading through reports, policies and programs published by the city, and scanning local news articles to understand public opinions on these programs. After examining Toronto's existing efforts, attention shifted to the core area of research, focusing on the goals and initiatives that have been implemented in other cities. North American cities were specifically targeted in this landscape analysis, as city staff found that they were most similar and transferable to the Toronto context. Evaluating the effectiveness of these programs, and analyzing how they could be applied within the context of Toronto was a critical part of the project. To measure effectiveness, data was collected on the state of green infrastructure in cities that had implemented initiatives. It was important to identify metrics that were used universally across cities in order to compare the progress of cities in each of the selected elements of green infrastructure. While some cities measured the effectiveness of their green roof programs by the amount of diverted storm water, or the money saved on heating and cooling bills, all cities published data on the number of square feet or square metres of green roof coverage in the city. Similarly, there was some diversity in metrics of tree canopy coverage, ranging from the number of trees to the number of square metres of urban canopy, but there was consistent reporting among cities of the percentage of the city covered by tree canopy. As a significantly broader topic, there was no widely used measurement to evaluate the public green spaces within the city, making comparisons between Toronto and other cities impossible. Equipped with a thorough understanding of how Toronto's performance

[9] Wolch, J., Byrne J., & Newell, J. (2014). Urban Green Space, Public Health, and Environmental Justice: The Challenge of Making Cities 'Just Green Enough'. *Landscape and Urban Planning, 125*, 234-244.

[10] Medical Officer of Health. (2015). Green City: Why Nature Matters to Health. *City of Toronto*.

compares with that of other North American cities, three recommendations were prepared to assist the city in identifying strategic improvements to its green infrastructure policies and programs.

Landscape Analysis

Toronto Initiatives

The City of Toronto has a number of policies and initiatives already in place to foster the inclusion of green infrastructure into urban developments. The green roof bylaw came into effect in 2010, mandating that any new commercial, institutional or residential building with a minimum of 2,000 square metres of gross floor space must make at least 20% of its roof space a green roof, with the exception of residential buildings under 20 metres tall. Under the bylaw, developers may apply for an exemption, reducing the amount of required green roof required, but there must be a cash-in-lieu payment of $200 per square metre of lost green roof.[11] The Eco-Roof Incentive Program was implemented by the city in 2009, and helps fund the construction of eco-roofs. Eco-roofs refer to either green roofs or cool roofs, with the key distinction being that green roofs grow vegetation while cool roofs are highly reflective of sun light, and help to reduce heat build-up. The portion of the program that supports the installation of green roofs provides $75 per square metre of green roof up to a total of $100,000.[12]

Toronto has adopted a Strategic Forest Management plan that focuses on increasing canopy cover, achieving equitable distribution of canopy, increasing biodiversity and awareness, promoting public stewardship and improving monitoring and information management about Toronto's urban forest. The plan identifies the primary threats to Toronto's urban forest and proposes a strategy of expansion and protection to mitigate these issues. Currently home to 10.2 million trees, Toronto plans to mitigate forest health threats, improve forest maintenance, balance urbanization impacts and address climate change impacts. Many of the proposed solutions to threats to the urban forest, as identified by the city, rely heavily on public involvement through education campaigns and encouraged community participation in sustainability programs.[13]

Similarly for public green spaces, Toronto is following the Parks Plan for the 2013-2017 period. The plan outlines twelve directions to be taken by the city with the goal of communicating with users, preserving and promoting nature, maintaining quality parks, and improving system planning. The steps outlined in this plan also focus on community involvement, but from the angle of increasing opportunities rather than

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[11] Toronto. (2016). Green Roof Bylaw. *City of Toronto*.

[12] Toronto. (2016). Eco-Roof Incentive Program. *City of Toronto*.

[13] Hart, J. (2013). Toronto's Strategic Forest Management Plan. *City of Toronto*.

focusing on education. Most of the directions detail steps to be taken by the city and its staff, with limited space for partnerships or engagement of stakeholders.[14]

Other Cities Initiatives

Chicago and Portland are some of the leading North American cities in green roof implementation. While neither city has implemented a bylaw, Portland requires the inclusion of an eco-roof or an Energy Star rated roof for any building project that receives funding from the Portland Development Commission or the Urban Renewal Areas initiative. Further, Portland requires that new buildings in the Central City District must comply with Portland's Central City Design Guidelines, which include the "integration of roofs and use of rooftops", and specify that eco-roofs are a means of fulfilling this requirement. Chicago also requires projects that receive public funding to implement green building initiatives, and while green roofs would qualify, they are not required.[15] Instead of mandating green roof implementation, Chicago and Portland have both ventured to make the inclusion of green roofs desirable to developers through incentives and Floor Area Ratio (FAR) bonuses. Similar to Toronto's incentive, Portland offers an incentive based on area, providing $5 per square foot of green roof to developers. Chicago's incentive is slightly different, instead offering a 50% rebate of the total cost of the green roof. Portland's FAR bonus is quite extensive, allowing buildings with 10-30% of green roof coverage an extra foot of building space per square foot of green roof, two feet of space in buildings with 30-60% coverage, and 3 feet of space in buildings with over 60% of green roof coverage.[16] Buildings must have the greatest of over 50% or 2,000 square feet of green roof coverage in Chicago to qualify for the FAR bonus. The bonus is then calculated by the equation: FAR Bonus = (area of roof landscaping in excess of 50% of net roof area ÷ lot area) × 0.30 × Base FAR.[17] Chicago also incentives green roof implementation through its Green Permit Program, where developers that include green building techniques, including green roofs in their development plans, are offered expedited building permits.[18]

As leading cities in their urban forest and tree canopy coverage, Washington and Austin have a number of interesting models that promote tree planting. Washington may have started with an advantage in this field, as the city was planned with an emphasis on trees and parks in the city, dating the inclusion of trees back to the days of George Washington's presidency. The city has still had to implement new programs to maintain this advantage though, and they have clearly dedicated significant resources to growing and protecting their trees, spending $10 million USD per year on their urban forest, which is more than any other city globally.[19]

[14] Toronto. (2013). Parks Plan2013-2017. *City of Toronto*.

[15] British Columbia Institute of Technology. (2012). Case Studies of Green Roof Regulations in North America 2006. *BCIT Commons*.

[16] Plant Connection. (2016). Green Roof Legislation, Policies & Tax Incentives. *Plant Connection, Inc.*

[17] BCIT, 2012

[18] Plant Connection, 2016

[19] Morris, R., Roosevelt, M., Xaquin, G., & Twombly, M. (n.d). Nine Cities That Love Their Trees. *National Geographic*.

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Washington also has a tree planting program that targets private land and residential tree planting, where individuals who purchase a tree and pledge to care for it for at least two years receive a $50 rebate on their tree.[20] Austin has also implemented programs that target private property and residential tree planting, which has proven effective for the city. This should not be attributed to the relationship between the government and the public as much as the important NGOs that act as a middleman. Municipal government agencies have formed strong partnerships with NGOs that have led to a free tree program, and educational programs on maintaining tree health.[21] The city also focuses on the urban forest as part of a larger environmental plan, ensuring that the water in Austin's tree-watering tanker trucks is all reclaimed wastewater, reducing the use of potable drinking water used for tree maintenance by a million gallons annually.[22]

There is no city that clearly ranks above the rest in its performance concerning public green spaces, as there is not one consistent metric to understand the progress of cities. There are a number of cities that have undertaken interesting projects to increase the amount of green space in the city, and each sets varying goals and measures success differently. Some cities focus on converting land into public green space, with Atlanta converting 22 miles of abandoned railroad tracks into parks and trails, and Pittsburg planting community gardens on vacant city lots. Other cities use proximity-based targets, like Vancouver and Philadelphia, where they pledge that no resident will live more than a 5 or 10 minute walk, respectively, from a public green space. Still other cities use models of community involvement as the best way to increase green spaces. This can be seen in San Francisco's community vegetable gardens, in Vancouver's GreenStreets program that allows for volunteer street gardeners, and in Boston, where protection of green spaces is run by volunteers.[23]

Comparing Toronto's Results

To evaluate the effectiveness of the green roof bylaw and the eco-roof incentive program in Toronto, it was important to look at the total coverage of green roofs in square feet throughout the city, and compare this with other cities. As shown in Table 1, at approximately 2 million square feet of green roof coverage, Toronto performs relatively well compared to other North American cities, ranking higher than Washington, Seattle New York and Portland. It falls significantly short of Chicago however, which boasts 7 million square feet of coverage in the city, and when compared with some of the leading cities in Asia and Europe, Toronto's performance comes across very weak. This metric only considers the actual coverage in area of a city, but when adjusted to consider the population of cities, Table 2 shows a slight shift. While Toronto continues to outrank New York, Washington and Seattle, it falls even further behind Chicago and Portland, which have

[20] District Department of the Environment. (2008). Plant a Tree in DC. *Government of the District of Columbia*.

[21] American Forests. (2016). 10 Best Cities for Urban Forests. *American Forests*.

[22] Morris, Roosevelt, Xaquin & Twombly, n.d.

[23] Siemens. (2011). US and Canada Green City Index. *Siemens AG*.

between 2.5 and 2.8 square feet of green roofs per capita, compared with Toronto's 0.7 feet. Adjusting for population brings Toronto's performance much closer to some of the leading cities in Asia, but brings the city much further away from Europe's frontier cities.
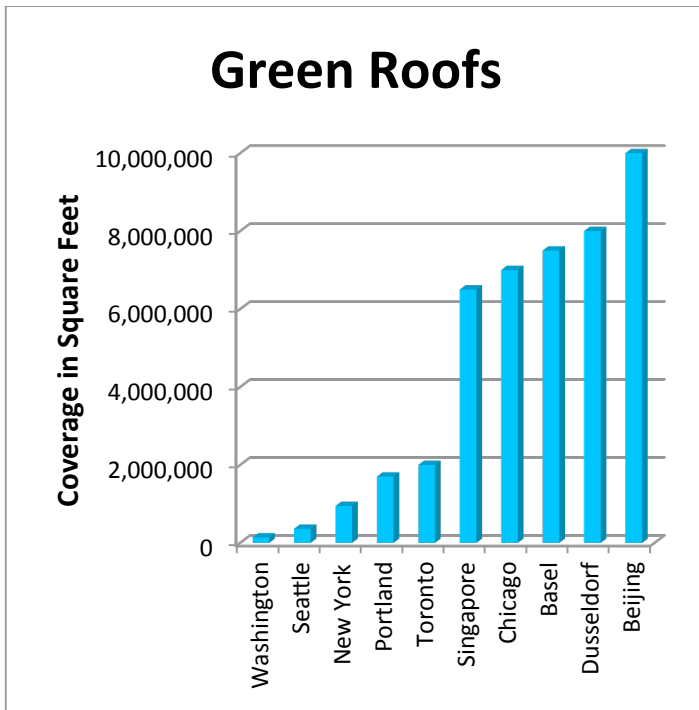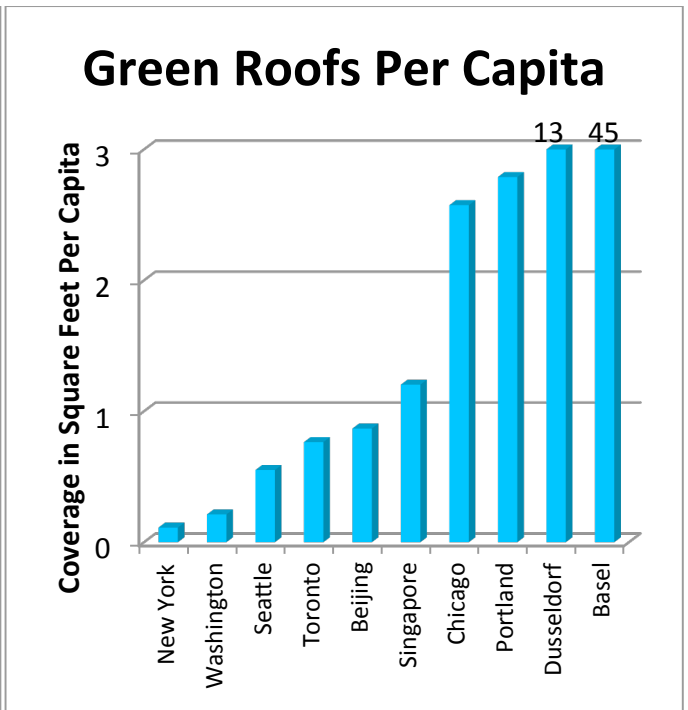
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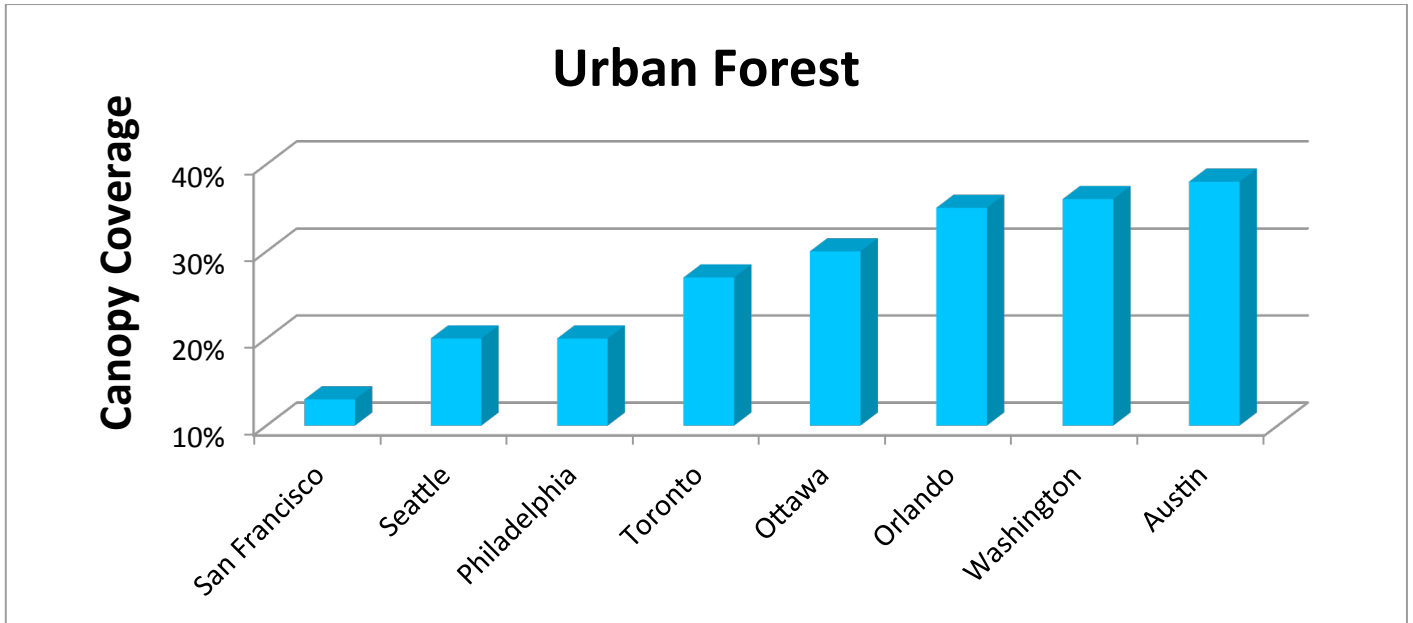

[24]

As show in Table 3, Toronto's performance in tree canopy coverage is similarly average when compared to other North American cities. The city estimates that it currently has between 26.6 and 28% tree canopy coverage, placing it significantly behind leading cities like Washington and Austin with 36% and 38% respectively.[25] Toronto's goal of 40% canopy coverage would make it a leading city compared to current standards, but by 2050, which is the end date for this target, this rate of coverage would again make Toronto average among cities with much higher goals.

[24] DC Greenworks. (2016). DCG by the Numbers. *DC Greenworks*; McIntosh, A. (2010). Green Roofs in Seattle. *University of Washington*; Jackson, J. (2011). New York's Growing Demand for Green Roofs. *The Guardian*; International Green Roof Association. (n.d). International Green Roof City Network: Case Study Portland, Oregon USA. *IGRA*; Toronto. (2016). Green Roofs. *City of Toronto*; Green Roof Technology. (2013). Green Roofs in Singapore. *Jorg Breunig & Green Roof Service LLC*; WendyCity. (2015). Chicago Green: Roofs. *WendyCityChicago*; Living Roofs World. (2012). International Green Roofs Policies. *Living Roofs World*.
[25] Toronto. (2016). Every Tree Counts: A Portrait of Toronto's Urban Forest. *City of Toronto*.

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Table 3

Urban Forest

Canopy Coverage

40%

30%

20%

10%

San Francisco   Seattle   Philadelphia   Toronto   Ottawa   Orlando   Washington   Austin

[26]

The city's performance in public green spaces is difficult to compare with other cities, since there is no widely used metric for evaluating public green spaces. While some cities measure the effectiveness of their projects on the amount of space that has been converted to green space, others use the time it takes for anyone in the city to walk from their place of residence to a park space as a metric. This inconsistency is a result of the variety in projects and the resulting differences in goals that are put forth by cities. In this way, it was impossible to compare the progress of Toronto against that of other cities.

Recommendations

A Competitive Toronto

Based on this information, the first recommendation made to the City of Toronto is to *increase green infrastructure programs and incentives to make Toronto competitive among North American cities.* The above comparisons between Toronto and some of the leading cities in North America, and around the world clearly show how much work still needs to be done in order for Toronto to position itself as an environmentally

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[26] Morris, Roosevelt, Xaquin & Twombly, n.d.

friendly city on the frontier of green infrastructure. The landscape analysis outlines initiatives that have been working for other cities, and emulating similar strategies could be beneficial to Toronto. It is also important to look at what activities Toronto has undertaken that leading cities have not, in order to identify what is not working well. The green roof bylaw in Toronto, for example, is not in place in cities that lead in green roof coverage, and further study within Toronto may show that requiring green roofs results in high rates of installation but very little maintenance and upkeep, making existing green roofs ineffective in Toronto. Similarly, Toronto may find that the public would be more incentivized by methods other than what is currently offered, as in the case of Portland, where there is a higher uptake of green roofs per capita, even though the city offers less financial compensation per square foot of installation. The initiatives that are the most effective in other cities could likely be applied within the context of Toronto, but further research needs to be dedicated to identifying the desires of Torontonians, and how to get them excited about green infrastructure programs.

A VISIBLY GREEN TORONTO

Once the city is competitive in its programs and policies concerning green infrastructure, the second recommendation is to *improve marketing strategies to brand Toronto as a green city and fuel behaviour*

change among the public. A significant body of research exists on the linkage between the behaviour of a person and his or her perceived surroundings. Studies would suggest that people who perceive their communities to be very environmentally friendly, adjust their behaviour to also be more environmentally conscious. With this knowledge, Toronto could find significant increases in all of its green infrastructure programs by simply improving the marketing of environmental initiatives that already exist within the city. Importantly, these initiatives do not need to be specifically green infrastructure projects, but rather programs that show broader comprehensive efforts to 'green' Toronto. Perhaps the best example of this would be in Toronto's transit system, where steps have already been taken to make the fleet more environmentally friendly. The below images show a comparison of how Toronto (top left) markets its hybrid electric buses, versus the campaigns launched in Singapore (top right), London (bottom left), and Winnipeg (bottom right).

An Equitable Toronto

Finally, it is recommended that the City of Toronto *focus on specific communities to improve equitability of green infrastructure projects throughout the city.* Figure 1 shows the distribution of green roofs across Toronto, illustrating a very noticeable concentration in certain areas of the city, and very sparse occurrences in most of the other areas of the city. Table 4 shows Toronto's 140 communities ranked on green space and tree cover, where communities that performed poorly in one category tended to also perform poorly in the other. This aligns with a trend that studies have shown to be present in a number of cities, Toronto among them, towards environmental initiatives being more easily accessible to affluent neighbourhoods.[27] The inequitable distribution of green infrastructure projects in Toronto, results in an equally inequitable distribution of associated benefits. The energy savings and temperature reduction associated with green infrastructure projects will not apply to areas of the city where green infrastructure is lacking. Similarly, the health benefits associated with park space and the improved air quality will be disproportionately concentrated in areas of the city where green infrastructure initiatives have been implemented most frequently and with the most success. Rather than focusing on strategies that improve Toronto as a whole, it may be most beneficial to target communities that are the most underserved by the existing initiatives. Increasing numbers in lower performing communities, will result in an overall increase of green infrastructure in Toronto, and will help the entire city realize the benefits of comprehensive green infrastructure plans.

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[27] Wolch, Byrne & Newell, 2014.

GREEN INFRASTRUCTURE

Figure 1
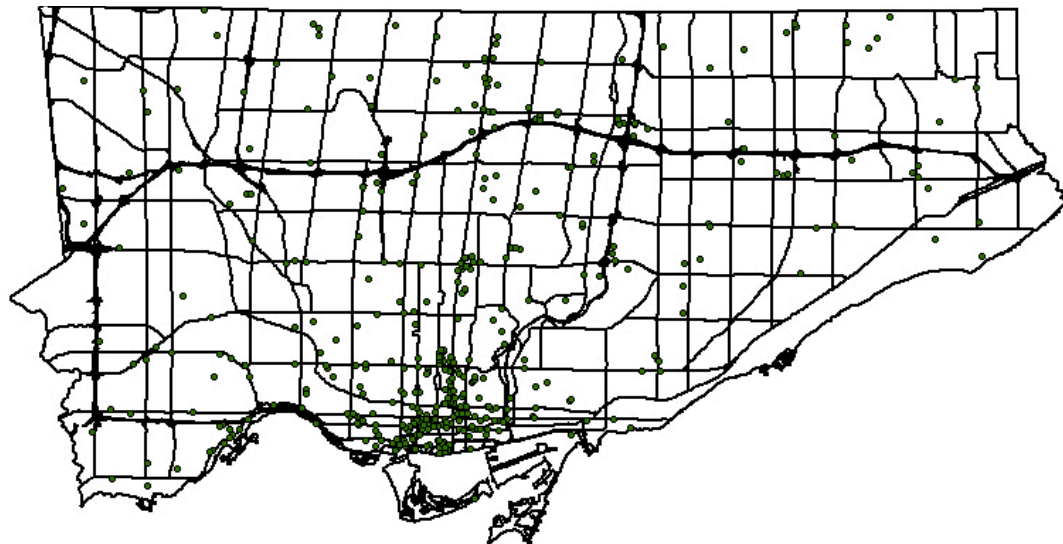
● **Green Roofs**

Table 4

	Green Spaces	Tree Cover
North St.James Town		
Little Portugal		
Church-Yonge Corridor		
Regent Park		
Bay Street Corridor		
Weston-Pellam Park		
Briar Hill-Belgravia		
Kensington-Chinatown		
Moss Park		
University		
Trinity-Bellwoods		
Blake-Jones		
Dufferin Grove		
Danforth		
Niagara		
Palmerston-Little Italy		
Playter Estates-Danforth		
Roncesvalles		
Woodbine-Lumsden		
Caledonia-Fairbank		
Mount Pleasant West		
Taylor-Massey		
Oakwood Village		
Corso Italia-Davenport		
Keelesdale-Eglinton West		
South Parkdale		
Danforth-East York		
Dovercourt-Wallace Emerson-Junction		
Ionview		
Yonge-St.Clair		
Etobicoke West Mall		
Wychwood		
Beechborough-Greenbrook		
Junction Area		
New Toronto		

| Oakridge | Greenwood-Coxwell | Runnymede-Bloor West Village | Rustic | Yonge-Eglinton | North Riverdale | Forest Hill North | Cabbagetown-South St James Town | Dorset Park | Eglinton East | Broadview North | Woodbine Corridor | Henry Farm | Humewood-Cedarvale | Yorkdale-Glen Park | Mount Dennis | High Park North | Old East York | Black Creek | Thorncliffe Park | Long Branch | Rexdale-Kipling | East End-Danforth | Annex | Lambton Baby Point | Maple Leaf | Weston | Kennedy Park | Brookhaven-Amesbury | Pleasant View | Casa Loma | Englemount-Lawrence | Elms-Old Rexdale | Flemingdon Park | Clanton Park |

| Humber Summit | Humbermede | Steeles | Milliken | Markland Wood | Mimico | Pelmo Park-Humberlea | Alderwood | Forest Hill South | Lawrence Park North | Scarborough Village | Willowdale West | Glenfield-Jane Heights | Humber Heights-Westmount | Malvern | Agincourt North | Clairlea-Birchmount | Mount Olive-Silverstone-Jamestown | Don Valley Village | Waterfront Communities-The Island | Westminster-Branson | Kingsway South | Agincourt South-Malvern West | Mount Pleasant East | The Beaches | Highland Creek | Newtonbrook West | Thistletown-Beaumond Heights | Rockcliffe-Smythe | Victoria Village | Hillcrest Village | South Riverdale | Newtonbrook East | Kingsview Village-The Westway | Guildwood |

| Willowridge-Martingrove-Richview | Tam O'Shanter-Sullivan | Bendale | Centennial Scarborough | Bathurst Manor | Lawrence Park South | Bayview Woods-Steeles | Willowdale East | Wexford/Maryvale | Princess-Rosethorn | Birchcliffe-Cliffside | O'Connor-Parkview | York University Heights | Leaside-Bennington | L'Amoreaux | Morningside | Bedford Park-Nortown | Eringate-Centennial-West Deane | Bayview Village | Downsview-Roding-CFB | Cliffcrest | Stonegate-Queensway | Rosedale-Moore Park | Woburn | High Park-Swansea | Edenbridge-Humber Valley | Lansing-Westgate | West Humber-Clairville | Islington-City Centre West | Parkwoods-Donalda | St.Andrew-Windfields | West Hill | Banbury-Don Mills | Bridle Path-Sunnybrook-York Mills | Rouge |

Lowest performing 25% **Upper middle performing 25%**
Lower middle performing 25% **Highest performing 25%**

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